What is the modelling community looking for in the next generation of traffic models?

Jenny Stocker, David Carruthers

Cambridge Environmental Research Consultants

APRIL (Air Pollution Research in London) Transport sub-group
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• **Current status** of traffic and emissions data used in local air dispersion models

• **Obvious omissions**!

• **Potential improvements** to air dispersion modelling, focusing on data available from new traffic and emissions modelling techniques

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Current status

- Source of emissions data for atmospheric dispersion modelling for London is the LAEI
- Focus on major road traffic sources that are modelled explicitly – similar issues apply to minor roads, rail and aircraft
Current status: spatial resolution

- Look at a single road in the LAEI, for instance Oxford Street
- The LAEI provides traffic data as output from the traffic model, in links (some links have more than 2 vertices)
- The relevant traffic information (speeds, flows) do not vary along neighbouring links
Current status: spatial resolution

- For dispersion modelling, if speeds and flows don’t vary, then the emissions are the same for all links - so links are combined
- Away from junctions predicted concentrations along the road are approximately the same
- So any link-related detail from the traffic model is omitted from the dispersion modelling
Current status: temporal resolution

- The same emission rates result in different ground level concentrations at different times of the day (e.g., variations in wind speed, chemistry effects).
- Even annual average calculations will be wrong if no temporal variation in emissions are included.
- LAEI includes:
  - Annual Average Daily Traffic and
  - Average speeds

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**CERC**

Daily, diurnal hourly traffic flow variations (plot from LAEI documentation, profiles not provided in LAEI)
Current status: temporal resolution

- In the ADMS dispersion models, concentrations are modelled on an **hourly** basis.
- 3 diurnal profiles of emissions are included: Average weekday, Saturday, Sunday
- Diurnal profiles calculated based on:
  - Available ATC or traffic model data
  - Adjustment for speed variations
  - Fleet composition (rarely included)

Adjustment for speed may not change the average emission, but does change the peaks, so will affect concentrations.
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Including flow *and* speed variations leads to emissions variations of up to a factor of 2 at peak times, which can lead to significant differences in modelled concentrations

- The profiles can be assigned on a **road-by-roads basis**, but more generally **average profiles** are used, for instance ‘central’, ‘inner’ and ‘outer’ London, plus motorways.
- Monthly profiles can also be included
- Alternative to diurnal profiles: detailed hour-by-hour emissions, 8760 values
Clearly, these average profiles are not appropriate for use at all sites.

There are at least 7 ‘enhanced’ sites in London (including Marylebone Road) where there are ATCs, ANPRs (Euro classes) and periodic manual counts.

Are these data downloadable from London Air?
### Obvious omissions!

<table>
<thead>
<tr>
<th>Item</th>
<th>Current approximation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diurnal profiles of traffic counts &amp; speed</td>
<td>General profiles assumed</td>
</tr>
<tr>
<td>Road widths</td>
<td>Assume width based on road type (A road, B road etc)</td>
</tr>
<tr>
<td>Canyon heights and widths</td>
<td>Ad hoc information, where available</td>
</tr>
<tr>
<td>Lane-by-lane traffic data</td>
<td>Ad hoc information, such as bus lanes, where available</td>
</tr>
<tr>
<td>Speed variation by vehicle type</td>
<td>Ad hoc information, such as slower bus speeds</td>
</tr>
<tr>
<td>Road gradients and elevations</td>
<td>Rarely included, unless very detailed study performed</td>
</tr>
<tr>
<td>Queuing/idling/traffic congestion</td>
<td>Included for detailed modelling</td>
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</tbody>
</table>
**Potential improvements: emissions data**

- Air dispersion modelling is performed at different scales.
- Emissions data are therefore required at different resolutions.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Example</th>
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</thead>
<tbody>
<tr>
<td>Large-scale strategic modelling</td>
<td>Population exposure calculations</td>
</tr>
<tr>
<td>Detailed studies</td>
<td>Assessing AQMAs, EIAs for new developments</td>
</tr>
<tr>
<td>‘Micro’ modelling</td>
<td>Detailed modelling at hotspots</td>
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</tbody>
</table>

The ‘.hfc’ file can be used to enter emissions profile data on a link-by-link basis for every hour of the year.

- Related data:
  - ‘micro-scale’ concentration measurements,
  - ‘micro-scale’ meteorological measurements,
  - ‘micro-scale’ dispersion modelling.
Potential improvements: ‘Micro-scale’ dispersion modelling

- Dispersion models predict ensemble averages i.e. they average over variations in meteorology and emissions to predict concentrations averaged over 1 or more hours.

- In order to perform ‘micro-scale’ dispersion modelling, fluctuations have to be taken into account; results given in terms of probabilities of exceedence of a threshold concentration.

- Ensemble mean plume: greater plume spread, lower maximum concentration.
### Potential improvements: associated data

<table>
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<th>Item</th>
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<th>Possible data sources?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diurnal profiles of traffic counts &amp; speed</td>
<td>General profiles assumed</td>
<td>Enhanced monitoring sites (specific site data only), Traffic modelling (road-by-road)</td>
</tr>
<tr>
<td>Road widths</td>
<td>Assume width based on road type (A road, B road etc)</td>
<td>GIS analysis of 3D buildings dataset with improved road centreline data</td>
</tr>
<tr>
<td>Canyon heights</td>
<td>Ad hoc information, where available</td>
<td></td>
</tr>
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</tbody>
</table>
Potential improvements: other issues

• Another non-linear effect in the relationship between emissions and concentrations is **Vehicle Induced Turbulence (VIT)**

\[
\sigma_v = b \sqrt{\frac{\sum_{i=1}^{m} N_i U_i A_i}{W}}
\]

- \(\sigma_v = \text{VIT}\)
- \(m = \text{number of vehicle categories}\)
- \(N_i = \text{number of vehicles}\)
- \(U_i = \text{vehicle speed}\)
- \(A_i = \text{vehicle cross section}\)
- \(W = \text{road width}\)
- \(b = \text{parameter}\)

i.e. flows and speeds are required explicitly in the air dispersion model to calculate VIT – these are currently estimated using a back calculation when detailed emissions are imported into the model.

• Emissions from a range of vehicles are usually grouped together. But these vehicles may have different **exhaust heights**. The source height is an important parameter in dispersion modelling - and significantly effects ground level concentrations.

• **Non-exhaust emissions**
Concluding remarks

• Concentrations are not linearly dependent on emissions so average speed/flow data are not sufficient
• Spatial variation of emissions:
  – Current LAEI has many links with the same average flows and speeds
  – Link by link variations from traffic/emissions models would generate variations dependent on local driver behaviour (eg junctions, bus stops, queuing)
• Temporal variation of emissions:
  – Current LAEI includes average speed and flows on each link, so general temporal variations are derived
  – Traffic/emissions models should be able to provide this detail on a link by link basis
• Simplifications of spatial/temporal data may be necessary depending on the resolution of output required
• Other related data eg road widths, canyon heights are independent of emissions, but can significantly affect concentrations
• ‘Micro-scale’ dispersion modelling requires new approaches